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Concerned  
Scientists

# Climate Change Impacts and Solutions for Pennsylvania

## How Today's Actions Shape the State's Future

**F**rom colonial times to the founding of the United States and its growth into a global power, Pennsylvania's people and resources have played a leading role in shaping the destiny of our country. Endowed with bountiful forests, fertile soils, extensive coal seams, and navigable rivers, the state created a thriving industrial economy that helped spur the prosperity of a young nation. For much of the past century, Pennsylvania has worked successfully to diversify its economy as the Rust Belt industries of coal, steel, and manufacturing waned; today the state economy owes at least as much to its service industries and modern manufacturing sectors. Many of its cities, towns, and rural regions, however, have not fully recovered from the decline of these traditional industries. Climate change will only add to the state's economic challenges while also dramatically altering many aspects of its economy, character, and quality of life.

Global warming is already making a mark on the landscape, livelihoods, and traditions of Pennsylvania, and over the coming decades the impacts are expected to grow more substantial across the state. They may include longer and more intense summer heat waves, reduced winter snowpack, northward shifts in the ranges of valued plant and animal species, and declining yields of key agricultural crops.

Some further global warming is unavoidable because emissions of heat-trapping gases such as carbon dioxide (CO<sub>2</sub>) can persist in the atmosphere for decades or centuries. CO<sub>2</sub> acts like a blanket, trapping heat and keeping the earth warm. But the magnitude of warming that occurs later this century depends largely on energy and land-use choices made within the next few years in the state, the nation, and the world. Because humans are largely responsible for current global warming, changing our actions can limit the severity and extent of impacts and thus the degree to which we will need to adapt.

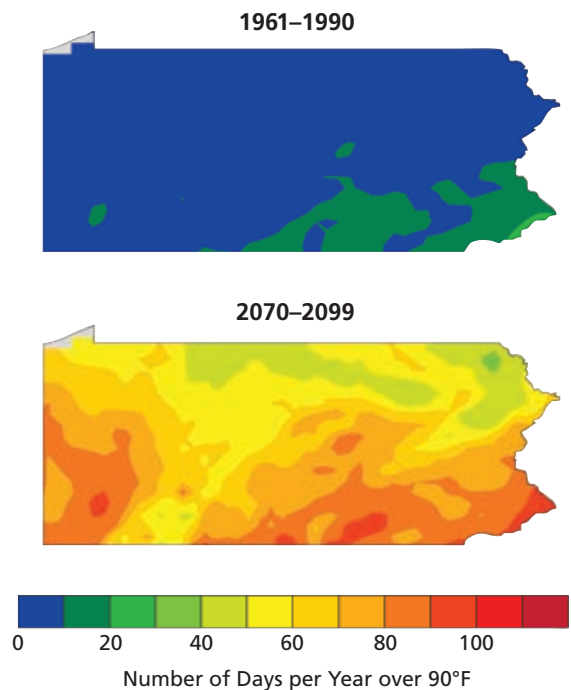
Many striking differences in the scale of climate change impacts can be expected, depending on whether the world follows a higher- or lower-emissions pathway. The first (the higher-emissions scenario) is a future in which societies—individuals, communities, businesses, states, and nations—allow emissions to continue growing rapidly; the second (the lower-emissions scenario) is one in which societies choose to rely less on fossil fuels and instead adopt more resource-efficient technologies.

These scenarios represent markedly different emissions choices that people may make.

The stakes for Pennsylvania's quality of life, and its very character, are great. If we follow the higher-emissions pathway, during the lifetime of today's kindergartener:

- Many Pennsylvanian cities can expect dramatic increases in the number of summer days over 90°F, putting vulnerable populations at greater risk of heat-related health effects and curtailing outdoor activity for many individuals.
- Heat could cause air quality to deteriorate substantially, exacerbating allergies, asthma, and other respiratory diseases.

**FIGURE 1: Temperature to Rise across the State**



**Statewide, Pennsylvania is projected to experience dramatic increases in the number of extremely hot days over the coming century, especially under the higher-emissions scenario. The greatest warming will be in the southwest and southeast regions, where daytime temperatures by late century (2070–2099) could hover over 90°F for nearly the entire summer.**

- Heat stress on dairy cattle may cause declines in milk production.
- Yields of native Concord grapes, sweet corn, and favorite apple varieties may decrease considerably as temperatures rise and pest pressures grow more severe.
- Snowmobiling conditions are expected to disappear from the state as winter snow cover shrinks.
- Widespread ski resort closures can be expected, despite increased snowmaking, as winters become too warm for snow—natural or human-made.
- Climate conditions suitable for prized hardwood tree species such as black cherry, sugar maple, and American beech are projected to decline or even vanish from the state.
- Substantial changes in bird life are expected, including loss of preferred habitat for many resident and migratory species. If Pennsylvania and the rest of the world take action to dramatically reduce emissions consistent with—or even

below—the lower-emissions scenario described in this report, many of the consequences noted above may be avoided, limited in scope, or postponed until late century, thereby giving society time to adapt. However, as many of the impacts are now unavoidable, some adaptation will be essential.

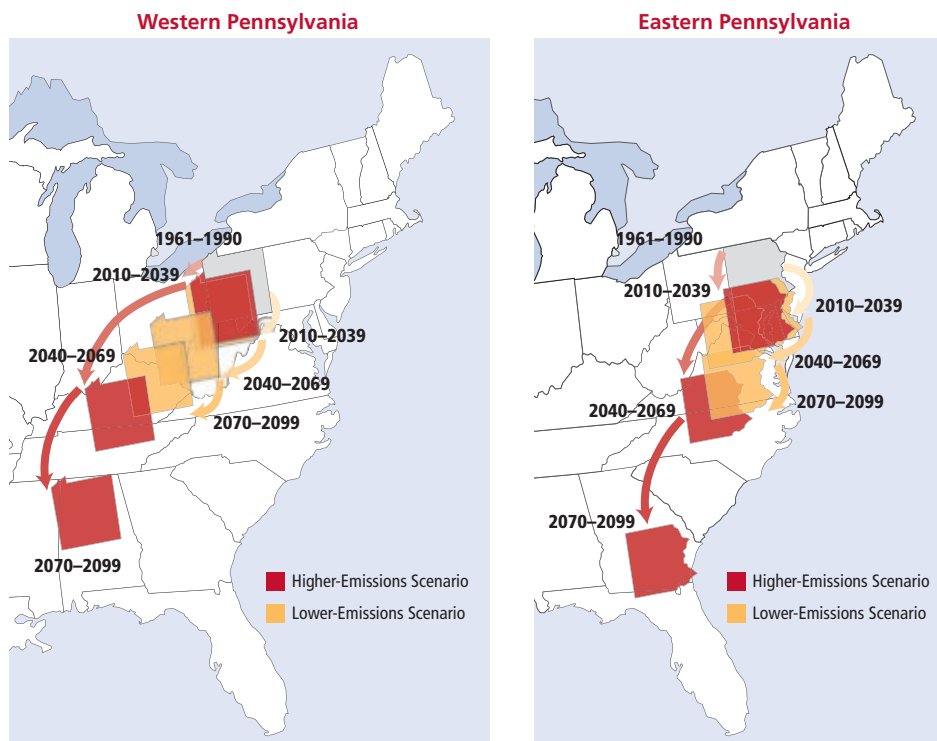
Pennsylvania has already shown its willingness to act. It has reduced heat-trapping emissions by driving investment in energy efficiency, renewable energy technology, and alternative transportation fuels; it has embraced wind power and other clean energy options (not only for energy generation but also for economic development); and it has moved to the forefront among “green power” purchasers.

But there are many more measures—based on proven strategies and available policies—that the state and its local governments, businesses, public institutions, and individual households can apply to this challenge. They require only the will to do so.

## How Will Emissions Choices Affect Pennsylvania’s Future Climate?

The Appalachian Mountains sweep diagonally across the Commonwealth of Pennsylvania from southwest to northeast, dividing it into distinct climatic regions. To the northwest lies the Allegheny plateau, which endures more severe winters, greater amounts of snowfall, and more frequent rainfall than other parts of the state. This precipitation feeds the headwaters of the Susquehanna, the Delaware, the Allegheny, and the Monongahela rivers.

Central Pennsylvania is a fertile landscape of valleys and ridges that experiences the state’s greatest extremes in temperature and rainfall and its heaviest snowfall. Southeast Pennsylvania includes the Piedmont plateau and the coastal plain of the Delaware River, which enjoy a milder winter climate but endure longer and hotter summers than the rest of the state. The largest cities—Philadelphia and Pittsburgh—are situated in the state’s more moderate climate regions.



Pennsylvania's climate has already begun changing in noticeable ways. Over the past 100 years, annual average temperatures have increased by around 0.5°F and annual average rainfall has been steadily increasing in all regions but the central southern. Winters have warmed the most, and in many Pennsylvania cities the number of extremely hot (over 90°F) summer days has increased since the 1970s. Decreasing snow cover—a statewide trend—has accelerated its decline in the past few decades. Each of these changes is consistent with the effects expected from human-caused climate change.

As the state continues to warm, even more extensive climate-related changes are projected, with the potential to transform aspects of Pennsylvania as we know it.

**Over the next several decades (2010–2039), compared with the historic period (1961–1990), the following changes can be expected under either emissions scenario:**

- Annual average temperatures across Pennsylvania are projected to increase by 2.5°F.
- Much of the state can expect substantially more days over 90°F—in most cases, at least a doubling.
- The area of the state that typically experiences 30 days or more of snow in winter is projected to shrink by roughly half.
- Precipitation is expected to increase statewide by more than 5 percent above the historical average.

**By late century (2080–2099), if heat-trapping emissions remain high:**

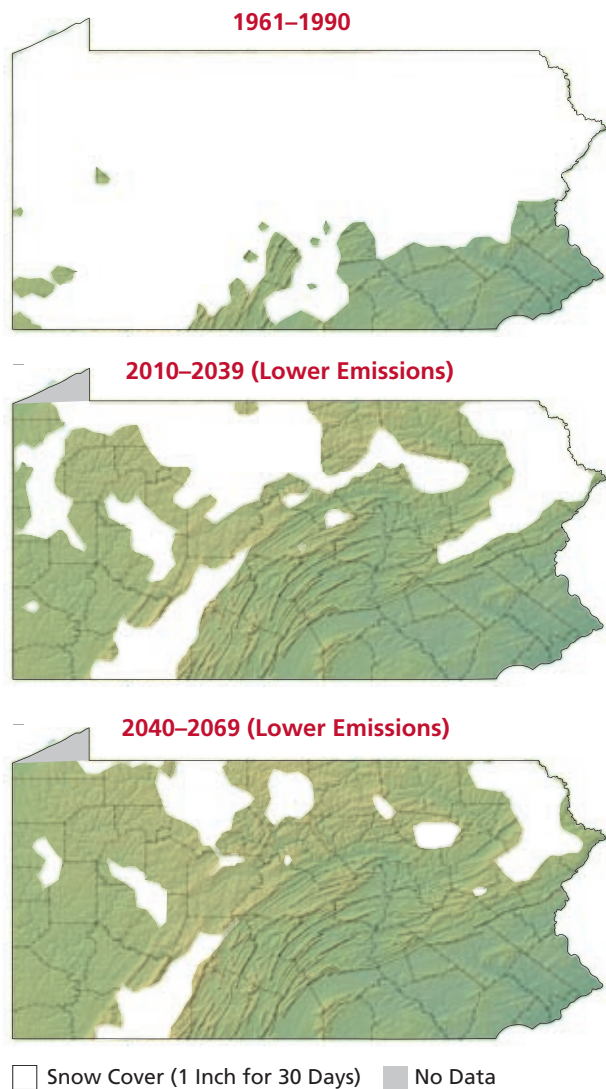
- Winter temperatures are projected to rise 8°F above historic levels and summer temperatures are projected to rise 11°F.
- Most of the southern half of the state is projected to endure more than 70 days a year with temperatures higher than 90°F.
- The characteristic snow season of Pennsylvania is projected to disappear.
- Precipitation is expected to increase by more than 10 percent statewide.

Under a lower-emissions future, the changes are projected to be about half as great as those listed above.

Most of the changes in climate over the next several decades are unlikely to be significantly curbed by any reductions in emissions of heat-trapping gases undertaken in Pennsylvania and the rest of the world during that period. These near-term changes have already been set in motion by emissions over the past few decades. Two factors explain the delayed response of the climate: many heat-trapping gases remain in the atmosphere for tens or even hundreds of years, and the ocean warms more slowly than the air in response to higher concentrations of such gases. Thus policy makers and communities across Pennsylvania must begin adapting to the unavoidable consequences of this warming.

Toward mid-century (2040–2069) and beyond, however, the extent of further warming will be determined by actions taken to reduce emissions—starting now and continuing over

**FIGURE 3: The Changing Face of Winter**



**A traditional Pennsylvania winter may become increasingly rare as the state's climate changes in the next several decades. White areas on the map are those that have at least a dusting (one inch or more) of snow cover for 30 days in the average year. Historically, three-quarters of Pennsylvania experienced this type of snow season. Under either emissions scenario, the area with such snow cover shrinks by roughly half in the next several decades and by three-quarters by mid-century, and there is essentially no snow cover by late this century. But while climate models suggest that the loss of winter snow in Pennsylvania will be difficult to avoid, the avoidance of other dangerous impacts is well within reach.**

Note that "lake-effect" snow in northwest Pennsylvania near Lake Erie was not modeled in these projections; areas without data are shown as gray on the map.

the next several decades. While such actions in Pennsylvania alone will not stabilize the climate, the state can nevertheless play a significant role in responding to this global challenge. Pennsylvania contributes 1 percent of total global emissions of carbon dioxide, and of all U.S. states it is the third-highest in emissions from fossil-fuel sources, behind Texas and California.

# What Might the Projected Climate Change Mean for Pennsylvania?

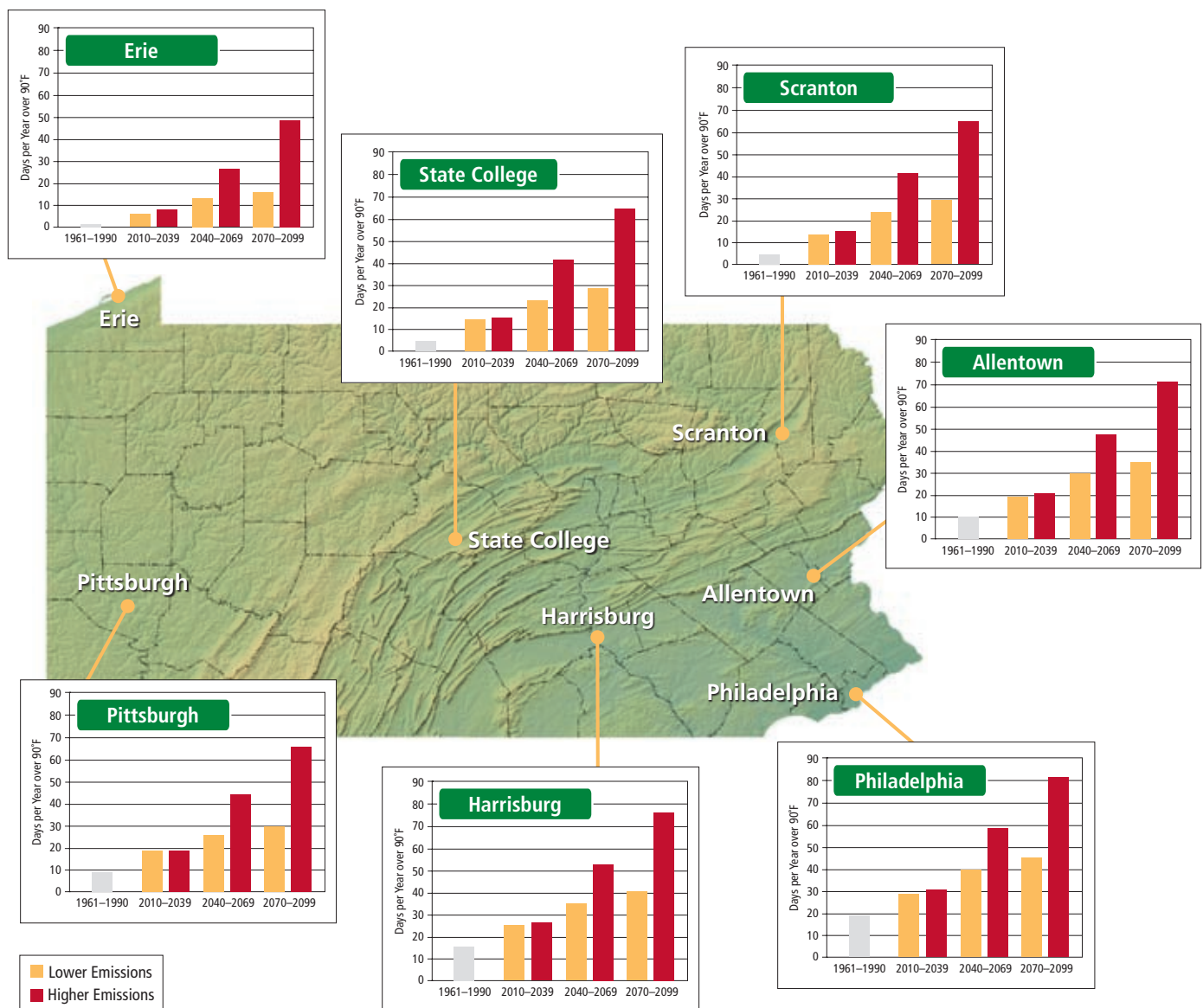
## CITIES AND TOWNS

Global warming is expected to increase the risks of many types of climate-related illnesses and even death, especially in Pennsylvania’s urban areas. In Philadelphia and other cities and towns throughout the state, extreme heat and air pollution events already generate headlines each summer and raise public concern. With aging infrastructure, aging populations, and health care systems

already under strain, cities and towns face a serious threat from climate change. Today’s emissions choices will help determine the severity of these risks and also how tolerable the future climate conditions in Pennsylvania’s cities will be.

- Cities such as Allentown, Pittsburgh, Scranton, and State College have historically averaged fewer than 10 days a year over 90°F. By mid-century under a higher-emissions future, these cities may endure more than 40 days over 90°F. By late century this number could rise to 65 days or more, though it would roughly be halved under a lower-emissions future. The most dramatic warming would be in cities in the southwestern and southeastern parts of the state, where daytime temperatures by late century could exceed 90°F for nearly the entire summer.

FIGURE 4: Extreme Heat in Our Cities



Cities such as Allentown, Pittsburgh, Scranton, and State College have historically averaged fewer than 10 days a year over 90°F. By mid-century under a higher-emissions future, these cities may endure more than 40 days over 90°F. By late century this number could rise to 65 days or more, though it would roughly be halved under a lower-emissions future. The most dramatic warming would be in cities in the southwestern and southeastern parts of the state, where daytime temperatures by late century could exceed 90°F for nearly the entire summer.

century this number could rise to more than 65 days. These projections would roughly be halved, however, under a lower-emissions future.

- By late century under a higher-emissions future, Allentown, Harrisburg, Philadelphia, Pittsburgh, Scranton, and State College could each experience some 24 or more days over 100°F during the summer, compared with the one or two such days they typically experience at present. Under a lower-emissions future, the number of days per year over 100°F would average seven or fewer.
- In the Philadelphia metropolitan area, the number of days failing to meet the federal ozone standard is expected to at least quadruple under the higher-emissions scenario if local vehicular and industrial emissions of ozone-forming pollutants are not reduced.
- As both temperatures and CO<sub>2</sub> levels rise, increases can be expected across Pennsylvania not only in the production of pollen grains but potentially in the allergenic potency of those grains.

Climate change will also help determine the future infrastructure and resource management challenges that Pennsylvania cities will face. For instance:

- Increased rainfall amounts could drive greater failure of combined sewer systems unless costly system overhauls are undertaken.
- Accelerated sea-level rise could worsen Philadelphia's water-supply challenges by increasing salinity in the Delaware River/Estuary system.

The costs of adapting to such changes could be enormous, particularly for cash-strapped communities.

## AGRICULTURE

From the stone barns of Lancaster County to the vineyards that rim Lake Erie's shore, agriculture remains a scenic centerpiece of Pennsylvania's identity. Pennsylvania retains one of the largest rural populations in the United States. Some 59,000 farms, many of them small and family-run, nestle among the state's hills, forests, and burgeoning suburbs, maintaining an agricultural tradition that in many areas goes back 200 years or more.

Dairying is the top agricultural industry in the state, with a 2002 commodity value of \$1.4 billion. Major cash crops include corn, vegetables, mushrooms, and fruits (including grapes and apples). Continuing changes in temperature, rainfall, and atmospheric levels of CO<sub>2</sub> will affect—both positively and negatively—Pennsylvania's crops and livestock as well as the pests, pathogens, and weeds that threaten them. The Intergovernmental Panel on Climate Change's most recent assessment, for example, projects that "moderate climate change" will likely increase yields of crops such as corn and soybeans by 5 to 20 percent over the next few decades, thanks to warmer temperatures, a longer growing season, and the "fertilizer effect" of higher levels of CO<sub>2</sub>.



**Dairy cows are being sprayed to help keep them cool. Under the higher-emissions scenario, dairy farmers face substantial reductions in milk production later this century as very hot days become more commonplace. Adaptation options include the installation of cooling systems in dairy facilities.**

Other global warming impacts, however, may outweigh such benefits. As temperatures increase, the state's prized sweet-corn crop may face reduced yields because of summer heat stress and increased pest and disease outbreaks. Hotter summers without an increase in summer rainfall could require that traditionally rain-fed crops be irrigated. High-value fruit crops may no longer experience the winter chilling conditions required for optimal fruit production and may also face increased pressures from insect pests.

### **Under the higher-emissions scenario, by mid-century:**

- Without new investments in methods to cool dairy cows, increasing summer heat stress is projected to depress milk production in Pennsylvania by at least 10 percent.
- The Concord Grape Belt may achieve adequately cold winter temperatures in just one out of two winters, potentially causing large reductions in grape harvests.
- The chilling requirement for certain apple varieties may be met in just 50 to 60 percent of winters in the southeastern part of the state, including Adams County (the state's major apple-producing area).
- Most of Pennsylvania's cornfields could experience consistent pressure from flea beetle/Stewart's wilt outbreaks.

Although farmers have often proven adaptable to changing weather patterns and market demands, they face greater uncertainty, risk, and expense as the pace and scope of climate change increase. The economic pressures will be felt both by large operations and small family farms, potentially threatening traditional livelihoods and unique lifestyles such as those of the Amish.

# Global Warming Impacts and Solutions in the Keystone State

**IMPACTS.** Continuing changes in temperature, rainfall, snow cover, and other climate variables will affect the state, from its farmland to its cities.



Temperatures exceeding 90°F are projected to become common by mid-century, increasing human health risks such as heat stress, heat exhaustion, and life-threatening heatstroke. Such risks disproportionately affect those who are poor, elderly, very young, suffering from chronic diseases, or otherwise unable to escape the heat.



Global warming could increase the levels of airborne pollen and lung-damaging air pollution. Poor air quality increases the risk of respiratory illnesses such as asthma, chronic bronchitis, and emphysema. Higher temperatures can prolong the pollen-allergy season while elevated CO<sub>2</sub> levels accelerate the productivity of key pollen-allergen sources.



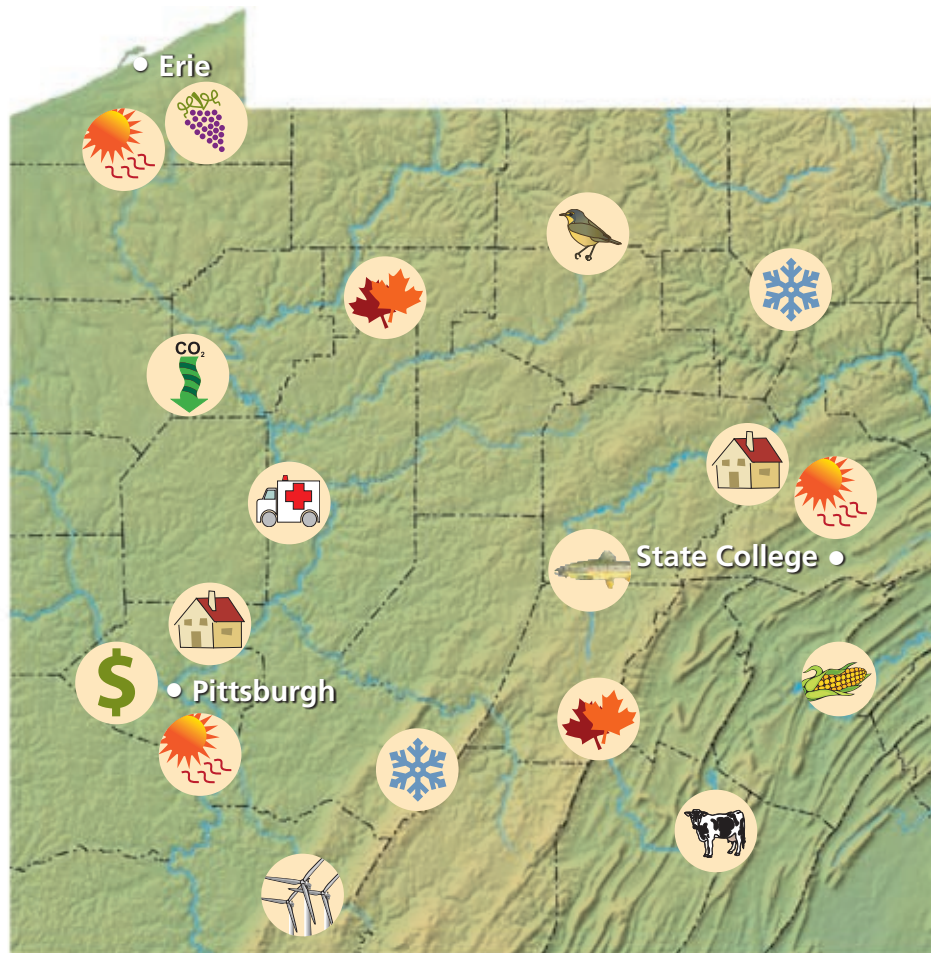
Pennsylvania is the country's fourth-largest producer of apples, grown mostly in the southeastern part of the state. By mid-century under the higher-emissions scenario, only half the winters in the southern part of the state would meet the cold-temperature requirements of popular varieties of apples, including McIntosh and Granny Smith.



Pennsylvania's Concord grape industry, located near Lake Erie, is a major source for the nation's grape juice makers. This native grape requires cold winter temperatures for optimal flowering and fruit production. Under the higher-emissions scenario, warmer temperatures could pose a substantial challenge to Concord grape growers by mid-century.



Currently, summers in Pennsylvania are ideal for growing sweet corn. Under the higher-emissions scenario, many July and August days are projected by mid-century to be substantially hotter than today, thereby reducing the crop's yield and quality.



Dairy farming is the most economically important agricultural industry in Pennsylvania. Under the higher-emissions scenario, dairy farmers face substantial challenges later this century as hot temperatures and heat stress depress milk production.



Suitable forest habitat for maple, black cherry, hemlock, and others is expected to shift northward by as much as 500 miles by late century under the higher-emissions scenario. This will threaten tourism as well as lucrative timber such as world-renowned black cherry.

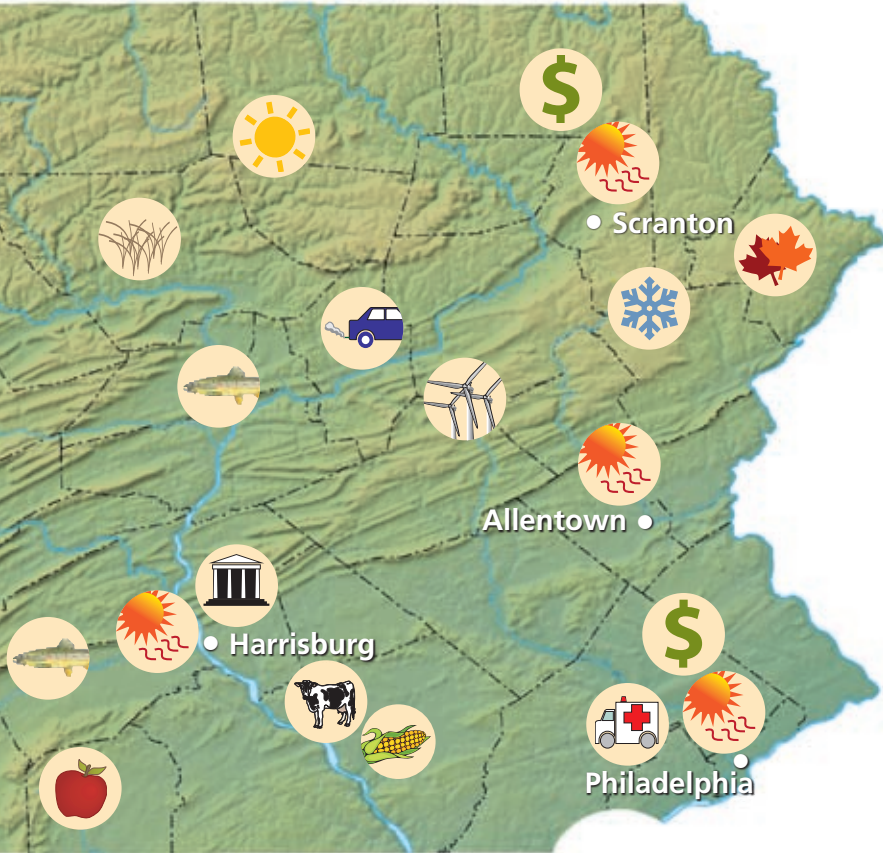



Warming climate and shifting distributions and quality of forest habitat is expected to cause substantial changes in bird life. As many as half of the 120 bird species modeled in Pennsylvania could see at least 25-percent reductions in their suitable habitat. Species at greatest risk include the ruffed grouse, white-throated sparrow, magnolia warbler, and yellow-rumped warbler.




As global warming drives up air temperatures and changes precipitation patterns, altered seasonal stream flows, higher water temperatures, and diminished shade along stream banks may follow. The native brook trout and smallmouth bass are particularly sensitive to such changes.


The choices we make today will determine the climate that our children and grandchildren inherit. This report portrays two possible futures: a higher-emissions scenario, characterized by continued heavy reliance on fossil fuels; and a lower-emissions scenario, marked by a pronounced shift away from fossil fuels toward greater reliance on clean energy technologies.





 Under either emissions scenario, the snow season is expected to retreat to the state's highland regions within just the next few decades. By late century, snow cover could be lost entirely in most years. Both the ski and snowmobile industries would be hard hit—snowmobiling harder at first, because it relies heavily on natural snow to cover the trails. Rising winter temperatures are expected to eventually render snow-making infeasible.


**SOLUTIONS.** Pennsylvania generates 1 percent of the world's heat-trapping emissions. Significant reductions in the state are essential to achieving deep reductions in CO<sub>2</sub> levels nationally—80 percent below 2000 levels by 2050, as many scientists have called for. Pennsylvania can meet this challenge by reducing emissions in many areas.


 Pennsylvania has abundant wind resources. Some large-scale wind installations are in place around the state, especially in the northeast and southwest, but this renewable resource remains largely untapped.


 Solar energy could help to meet electricity demand during heavy-use periods and is readily available for deployment in homes and businesses. Pennsylvania has more than five times the solar energy potential of neighboring New Jersey, yet only 1/40th as much installed solar-electric capacity.


 Energy efficiency in homes and businesses—both new and old—has large potential to reduce emissions as well as energy costs. Pittsburgh is already a national leader in green-building technology, and many of the state's academic institutions are going green.

 Reducing emissions from cars and trucks, which account for 25 percent of the Keystone State's total emissions, requires: (1) better fuel economy; (2) burning fuel with lower carbon content; and (3) reducing vehicle miles traveled through smarter development policies and improved public transportation.

 Existing coal-fired power stations may substantially reduce their heat-trapping emissions by replacing some of the coal with biomass such as wood chips or other wood waste. Trees and plants absorb carbon as they grow, and during burning they emit the same amount they absorbed during their lifetimes.

 Carbon capture and storage, a potential technique for capturing emissions from coal-fired power plants and storing them underground, has not yet been proven viable. There may be promising sites in many parts of the state, however, for pilot projects.

 A rapid transition to a clean energy economy will not happen without strong policies implemented at the municipal, state, and federal levels. For example, setting a price on carbon to help drive the market for clean energy is critical.

 A clean-energy economy will bring strong investments and good jobs to the state. This is already being seen in the establishment of wind and solar production plants, the growth in green-building trades, and the emergence of associated maintenance and operations jobs that cannot be done overseas.

Many of these symbols courtesy of the Integration and Application Network ([ian.umces.edu/symbols/](http://ian.umces.edu/symbols/)), University of Maryland Center for Environmental Science.



**Pennsylvania's silviculture (tree-growing) industry may face major risks and long-term management challenges, particularly under the higher-emissions scenario, as it attempts to adapt to the eventual decline of habitat for economically important trees such as black cherry. Park and wildlife managers could also face changes in recreational opportunities and the loss of critical wildlife habitats.**

## FORESTS

Pennsylvania acquired its name—Latin for “Penn’s woods”—in the seventeenth century from its seemingly endless expanse of ancient beech, hemlock, oak, and maple forests. Timber harvesting had reduced forest coverage to its lowest point—30 percent of the landscape—by the early 1900s, but Pennsylvania’s forests have been expanding ever since; currently, nearly 60 percent of the state is forested. These forests make Pennsylvania today’s number-one producer of hardwoods nationally, support 90,000 jobs in more than 3,000 businesses from sawmills to cabinet-making shops, and supply residents and tourists alike with myriad opportunities for hiking, fishing, birding, biking, hunting, and other outdoor pursuits.

Pennsylvania’s varied terrain and its position at a latitude where northern and southern species mingle allow it to support more than 100 native tree species. Most prevalent among them are the hardwoods such as sugar maple, red maple, black cherry, and red oak—which supply 90 percent of the state’s sawtimber—and softwoods such as eastern hemlock, white pine, and red pine. These forests have remained vital to the state’s economy and identity over the past several centuries. But the character of Pennsylvania’s forests and their contribution to its economy are poised to undergo major changes this century, depending on our emissions choices.

Climate plays a major role in determining suitable habitat for trees, as well as for other plants and wildlife. But as the climate warms, the areas that best meet each species’ requirements will shift northward by as much as hundreds of miles.

### **Under the higher-emissions scenario, by late this century:**

- Hemlock (the state tree) is projected to lose two-thirds of its current suitable habitat. Under the lower-emissions scenario it could lose less than half.
- Suitable habitat for the black cherry tree is expected to disappear from the state altogether. Possibly the most economically important tree species at risk, black cherry, currently supports a thriving timber and veneer industry.
- Suitable habitat for signature species such as sugar maple and American beech—both of which provide brilliant fall foliage—is projected to decrease.
- As many as half of the 120 bird species examined in Pennsylvania could see at least 25-percent reductions in their suitable habitat because of changes in climate and vegetation.

Because long-lived trees may persist for many decades in declining conditions, it remains highly uncertain what Pennsylvania’s forests will look like by late century. Some degree



**Skiing and snowboarding are better positioned than snowmobiling to adapt because resorts do not have to rely solely on natural snow. However, by mid-century warming temperatures could render snowmaking infeasible during much of the winter.**

of change in the landscape, however, is certain, with quite substantial change expected in a higher-emissions future.

## WINTER RECREATION

Millions of residents and tourists alike head for the woods and hills of Pennsylvania each winter, lured by more than 30 ski areas and 3,000-plus miles of public snowmobile trails. Winter recreation in the Commonwealth, from sledding in the city parks of Pittsburgh to riding horse-drawn sleighs through the frosty woods of the Poconos, traditionally revolves around snow. However, the face of winter in Pennsylvania is expected to change rapidly and profoundly this century as winter temperatures continue to rise.

Climate change is projected (both under lower- and higher-emissions scenarios) to cause a dramatic decline in the average number of snow-covered winter days across the state. Under either emissions scenario, the snow season is expected to retreat to the highland regions within just the next few decades. By late century it could be lost entirely in most years under the higher-emissions scenario. If lower emissions prevail, small, high-elevation areas of the state may preserve a modest snow season throughout this century, but projections show a similarly rapid decline elsewhere.

### In the next several decades, under either emissions scenario:

- The north-central region, which currently averages 18 days each winter with snowmobiling conditions (at least six inches of snow on the ground) could be reduced to a season of nine days on average.
- Only western Pennsylvania ski areas may remain viable, and even they may be economically vulnerable.

### By mid-century under either emissions scenario:

- Snowmobiling conditions are projected to diminish markedly, causing the snowmobile industry—which pumps an estimated \$160 million into the Pennsylvania economy each winter—to all but disappear.
- As temperatures warm and snowmaking becomes increasingly difficult, Pennsylvania is no longer expected to support viable ski operations.

The heavy costs to winter recreation industries could reverberate throughout the state's economic sectors, particularly tourism. Loss of other treasured winter pastimes, from snowshoeing and cross-country skiing to tubing and sledding, may have less impact on the economy than on the state's quality of life during its wet but increasingly snowless winters.

## How Can Pennsylvania Meet the Challenges of a Changing Climate?

From the Declaration of Independence to the steel used for the country's first railroads, Pennsylvania—the Keystone State—has a long history of laying our nation's foundations. By reducing heat-trapping emissions today, Pennsylvanians have a new historic opportunity: to set a national example of helping to protect our children and grandchildren from the most severe consequences of climate change. At the same time, effective adaptation strategies are needed to help reduce the vulnerability of Pennsylvania's residents, ecosystems, and economies to those changes that are now unavoidable.

Here in Pennsylvania, across the country, and around the world, there is growing momentum to meet the climate challenge. State legislation passed in 2008, for example, requires the appointment of a permanent climate change advisory committee, periodic assessment of climate impacts, an annual inventory of the state's heat-trapping emissions, and the development of a comprehensive climate change action plan. Concerted and sustained state efforts to reduce emissions—on the order of 80 percent below 2000 levels by mid-century and just over 3 percent per year on average over the next several decades—could help pull global emissions below the lower-emissions scenario described here.

Of course, the state's actions alone will not be sufficient to avoid dangerous climate change, but Pennsylvania generates

1 percent of global emissions—half as much as the United Kingdom, which has five times the population. If the United States and the world are to achieve the scale of emissions reductions needed, the state should figure prominently in a transition to a clean energy future—vigorously improving efficiency in buildings and industry to reduce energy demand while aggressively promoting a shift away from carbon-intensive coal toward an increasingly clean mix of low-carbon and renewable energy options. As a leader in technology, industry, and policy innovation and as a major source of heat-trapping emissions, Pennsylvania is well positioned to drive national action to reduce emissions.

### 1. EMISSIONS REDUCTIONS

The Commonwealth and its municipal governments, in partnership with other states, businesses, civic institutions, and the public, have a rich array of strategies and policies at their disposal to meet the climate challenge. These strategies and policies can reduce emissions in the following sectors:

**Electric power.** Because Pennsylvania has substantial coal resources, it is not surprising that over 40 percent of the state's total CO<sub>2</sub> emissions come from electricity generation, of which fully one-third is exported to other states on the East Coast. What probably *is* surprising is that Pennsylvania has some of

the most abundant, but largely untapped, renewable energy resources in the U.S. Northeast, including wind, solar, and forest and agricultural biomass.

Although the state enacted a requirement in 2004—called the Alternative Energy Portfolio Standard (AEPS)—that local utilities obtain 8 percent of their electricity by 2020 from clean, renewable resources, this percentage is modest compared with those of many other states and should be substantially increased. Such an increase would be consistent with Pennsylvania’s recognition that clean energy development can bring jobs and capital investment to the state. In recent years, for example, at least two renewable energy enterprises have located in the state: the Spanish wind-energy company Gamesa established its U.S. headquarters in Philadelphia, invested \$84 million, sited two manufacturing facilities and another office in the state, and created nearly 1,000 jobs; the German company Flabeg chose Allegheny County for its first U.S. solar-mirror production facility, which is expected to create 300 manufacturing jobs.

Another underused resource is energy efficiency. With caps on electric rates established during utility deregulation scheduled to begin expiring in 2009, implementation of strong energy efficiency programs throughout the Commonwealth could substantially dampen the impact on electric bills while reducing emissions.

Perhaps Pennsylvania’s toughest challenge is decreasing its dependence on coal for electric power. Coal is currently the cheapest of the fossil fuels used to generate electricity, but it is also the most carbon-intensive. Assessments have shown that Pennsylvania has large potential for geologic sequestration, whereby CO<sub>2</sub> emissions from power plants would be captured and then stored permanently underground—an option called carbon capture and storage (CCS). More research and the development of pilot projects will be required to establish CCS’s technical and financial viability. To avoid undermining its own and neighboring states’ efforts to reduce emissions, the state should permit no new coal-fired plants to be built until CCS is established.

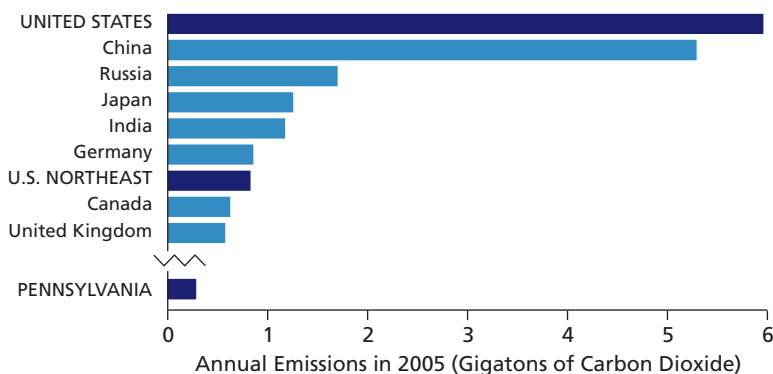
Another needed improvement to the state’s AEPS—which could help support the development of CCS technology—is to require that any nonrenewable resources used to meet the electricity standard be carbon-neutral via geologic sequestration or offset purchases by 2025. To assist in the near-term transition away from coal-fired electricity, the state’s electricity generators could begin co-firing sustainable biomass (such as timber processing residues) with coal in existing power plants, thus reducing the carbon content of the fuel.

**Buildings.** Enactment during the 2008 legislative session of a \$650-million suite of grant and loan programs—to support energy efficiency upgrades and installation of renewable energy equipment on residential, commercial, institutional, and industrial buildings—was a very positive step. Implementation efforts should draw on the experience of successful pioneering initiatives such as the West Penn Power Sustainable Energy Fund and the Keystone Home Energy Loan Program, as well as on the Pittsburgh area’s wealth of expertise in green building design, construction, technology, and related products. This region of the state has embraced green building, both for its primary benefits and as an economic development strategy, through systematic collaboration between the local design, construction, manufacturing, and higher-education sectors.

Adopting a requirement that any building substantially funded by the state be built to high “performance” standards would make Pennsylvania and its municipal governments leaders by example. At the same time, financial support for additional education and training for architects, engineers, builders, and local code officials would help speed the proliferation of these practices throughout the state.

**Transportation.** To reduce emissions from cars and trucks—which account for 25 percent of Pennsylvania’s total carbon emissions—state efforts must simultaneously address three critical components: vehicles’ fuel economy and emissions, the carbon content of fuels, and the amount of driving that Penn-

**FIGURE 5: 2005 Pennsylvania Emissions: Significant on a Global Scale**



**When compared with entire nations, Pennsylvania’s emissions are so high that this single state ranks as the world’s twenty-second largest emitter of CO<sub>2</sub>. Pennsylvania’s total emissions are higher than those of New York State and Wyoming combined, while its per capita emissions are more than double those of New York State.**

Note: U.S. emissions include those from the nine Northeast states, and Northeast emissions include those from Pennsylvania.

Source: Energy Information Administration. 2005. *International energy annual 2005*.



sylvanians do. While the Keystone State has adopted California's tailpipe-emissions standards for new vehicles (which would require reductions of approximately 30 percent below 2002 levels by 2016, beginning with the 2009 model year), implementation has been held up by an adverse decision by the U.S. Environmental Protection Agency. In the meantime, more state-government "leadership by example," together with incentives for businesses and individuals to purchase currently available low-emissions vehicles, could address the first component of a cleaner transportation policy.

The recently enacted production incentives and per-gallon content requirement for biodiesel and cellulosic ethanol in transportation fuels could help reduce emissions while supporting the state's farm economy. But the Department of Agriculture must ensure a full accounting of life-cycle emissions per unit of energy delivered and guard against adverse consequences for land use, water resources, and food supply. Finally, to influence the number of miles Pennsylvanians travel, policy makers should revisit the 2006 Pennsylvania Transportation Funding and Reform Commission's promising recommendations regarding integration of transportation-infrastructure funding with land-use and economic development policies, as well as those designed to stabilize and reform public transit system funding.

**Industries and large institutions** in Pennsylvania should take full advantage of the variety of programs and incentives created by the 2008 state legislation—in particular, those that encourage industries and large institutions to make investments in alternative energy systems and energy efficiency upgrades that help control their energy costs while reducing their emissions.

For example, loans and grants will be available to support the installation of wind turbines and geothermal heat pumps, as well as solar electric and solar thermal equipment, for which the large and unobstructed roof areas of industrial and institutional buildings are often well suited. The law also created an Alternative Energy Production Tax Credit, which can further subsidize the cost of such installations.

The state already has a jump on institutional leadership of this kind. More than 50 of the state's academic institutions, both large and small, have joined together in a consortium to support and expand greening programs on campus. This innovative effort can be significantly strengthened, as there are a great many opportunities for reducing energy use in campus buildings and vehicle fleets, securing electricity from renewable energy, educating the student body, and pursuing other emissions-reducing activities.

**Forestry and agriculture** policies in Pennsylvania can be designed to promote cost-effective management practices and systems that reduce emissions. The Commonwealth's Carbon Management Advisory Group, convened by the Department of Conservation and Natural Resources, made many specific recommendations in its 2008 report along these lines that can guide future policy development. Notably, the top policy recommendation for the forest sector—to reduce the rate of forested land conversion for development—is aligned with the transportation sector's imperative to arrest sprawling development patterns. In the agriculture sector, a highly practical and cost-effective strategy—capturing and using the methane from animal waste as a power source—is already being successfully employed on many farms throughout the state.

## 2. A STATE-FEDERAL PARTNERSHIP

Although Pennsylvania and its municipalities can achieve much with their own policies and resources, the scale of emissions reductions required suggests a strong role for the U.S. government. Federal climate policy, for example, can set a national price on carbon, making power plants that capture and store CO<sub>2</sub> emissions more cost-competitive in the marketplace. Carbon-policy options currently being debated in Congress might also generate resources to assist with reasonable transitions for coal miners and coal-dependent communities. Complementary federal policies, such as a national renewable electricity standard or stringent fuel-economy standards, may help stimulate energy and transportation solutions at the state level. And federal resources devoted to continued climate monitoring and assessments can provide essential information for use by states and communities in devising and implementing adaptation plans. Pennsylvania's U.S. senators and representatives must therefore support strong federal climate and energy policies that will help the state reduce emissions, transition to a promising clean energy economy, and prepare for the climate change that will occur in the interim.

## Scientists and Economists Call for Reductions in Heat-trapping Emissions

Several dozen Pennsylvania scientists and economists have joined more than 1,700 other Ph.D.s in climate-related science and economics across the United States in calling for swift and deep reductions in the heat-trapping emissions that cause global warming. The Pennsylvanians come from more than 20 institutions across the state, and join six Nobel laureates, 30 members of the U.S. National Academy of Sciences, and more than 100 members of the Intergovernmental Panel on Climate Change (IPCC) in this first-of-its-kind appeal by both scientists and economists.

The scientists warn policy makers of the growing risks of climate change, including sea-level rise, heat waves, droughts, floods, disease, and species extinctions.

The experts' statement calls for reducing U.S. global warming pollution 80 percent below 2000 levels by 2050. Their recommended first step is reducing emissions 15 to 20 percent below 2000 levels by 2020.

The Pennsylvania Climate Change Act, passed in mid-2008, does not specify any near or long-term targets for emissions reductions, but it does call for an advisory committee to report on potential climate change impacts on Pennsylvania's weather, economy, forests, recreation,

agriculture, and tourism. The advisory committee will outline the economic opportunities created by emerging technologies designed to reduce emissions and will produce a climate change action plan for Pennsylvania. This and other legislation on the horizon provide an opportunity for Pennsylvania to respond to the threat of climate change with emissions reductions commensurate with the challenge.

Economists point out that the costs of inaction would be devastating and that acting promptly is the most cost-effective way to limit the most dangerous consequences of climate change. Studies show that efforts to cut emissions to safe levels would cost between 1 and 2 percent of gross domestic product (GDP), while allowing climate change to proceed unabated would cost 10 to 20 percent of GDP. Implementing smart reduction strategies now will allow the economy to grow, generate new domestic jobs, protect public health, and strengthen energy security.

(For the U.S. scientists and economists' statement and the list of signatories, go to [www.ucsusa.org/climateletter](http://www.ucsusa.org/climateletter).)

### 3. ADAPTATION

Because global warming is already upon us and some amount of additional warming is inevitable, adapting to higher temperatures is now an essential strategy along with efforts to reduce emissions. Delay in reducing emissions increases the costs and limits the feasibility of adaptation, while taking aggressive steps to reduce emissions improves the likelihood that ecosystems and societies will be able to find effective ways to adapt.

Decision makers should first draw on our best scientific understanding of climate change and societal vulnerabilities, and then carefully consider the likely efficacy and broader

implications of available adaptation strategies. For each adaptation measure considered, decision makers must carefully assess the potential barriers, costs, and unintended social and environmental consequences.

### CONCLUSION

Global warming represents an enormous challenge, but we can meet this challenge if we act swiftly. The emissions choices we make today in Pennsylvania and throughout the nation and the world will shape the climate that our children and grandchildren inherit. The time to act is now.



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This document summarizes key findings from the report *Climate Change in Pennsylvania: Impacts and Solutions for the Keystone State*, a collaborative effort between the Union of Concerned Scientists (UCS) and a group of independent experts that assesses how global warming may further affect the climate, economy, and quality of life in Pennsylvania and explores options for meeting the challenge. The goal of this work is to combine state-of-the-art analyses with effective outreach to provide opinion leaders, policy makers, and the public with the best available science upon which to base informed choices about climate change mitigation and adaptation.

For more information on climate change impacts and solutions in Pennsylvania, and to download a copy of the report, visit [www.climateimpacts.org/pa](http://www.climateimpacts.org/pa). For more information on the science underpinning this work visit [www.northeastclimateimpacts.org/pa](http://www.northeastclimateimpacts.org/pa).



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